HIRAD Instrument Calibration and Brightness Temperature Image Accuracy, Precision and Resolution

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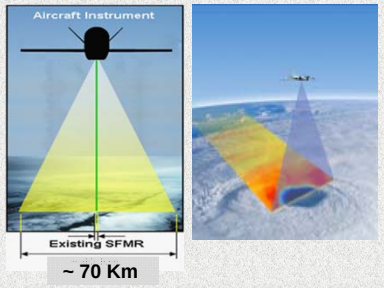
Hurricane Imaging Radiometer (HIRAD)

HIRAD utilizes NASA Instrument Incubator Technology:

- Provides unique observations of sea surface wind, temp and rain
- Advances understanding & prediction of hurricane intensity
- Expands Stepped Frequency Microwave Radiometer capabilities
- Uses synthetic thinned array and RFI mitigation technology of Lightweight Rain Radiometer (NASA Instrument Incubator)



Passive Microwave C-Band Radiometer
with freq: 4, 5, 6 & 6.6 GHz:
- *Version 1:* H-pol for ocean wind speed,
- *Version 2:* dual-pol for ocean wind vectors

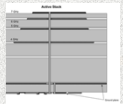
Performance Characteristics:
- Earth Incidence angle: 0° to 58-72° (see table at right)
- Spatial Resolution: 2-5 km,
- Swath: ~70 km for 20 km altitude

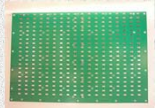
Observational Goals:
WS 10 - >85 m/s RR 5 - > 100 mm/hr

Frequency	Beamwidth (deg) nadir / 60 deg	NEΔT (K) nadir / 60 deg	Swath (deg) [NSF<10]
4 GHz	2.6 / 6.0	0.9 / 1.1	+/- 72
5 GHz	2.6 / 5.7	1.0 / 1.1	+/- 67
6 GHz	2.6 / 5.4	0.4 / 0.5	+/- 74
6.6 GHz	2.6 / 5.2	1.3 / 2.0	+/- 58

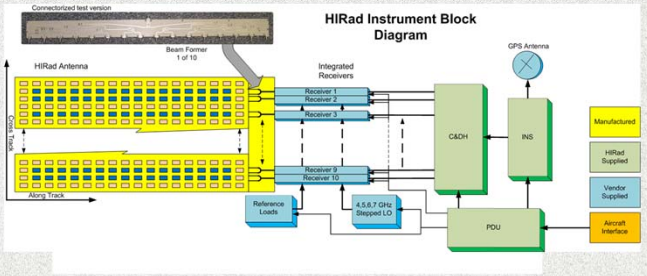
HIRAD System Design and Subsystem Elements

Antenna Subsystem


Multi-resonant Patch Element


Full Array of Patches


Radome



Functional Block Diagram
Multi-resonant antenna array (left)
Parallel receiver bank (center)
Correlator/Data handling/Power (right)

A/C Integration

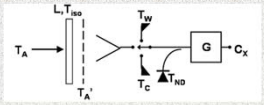

Integrated Subsystems
receivers in foreground
correlator/C&DH/Power in background


A/C Interface Pallet


Integrated onto A/C

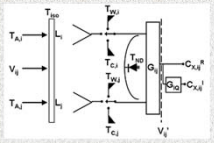
Instrument Forward Model and Calibration Algorithm

Self-Correlation (V_0)



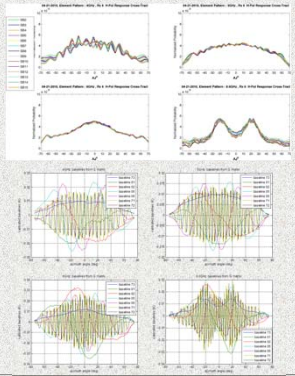
$$V_0 = T_A = [T_A' - (1 - L)T_{ant}]L^{-1}$$
$$T_A' = T_W - dT_{RX} - (C_W - C_A)G$$
$$G = (T_W - T_C)/(C_W - C_C)$$

Cross-Correlation (V_n, n>0)



$$V_{ij}^{R\prime} = (C_{A,ij}^{R} - C_{0,ij}^{R})G_{ij}L_{ij}^{-1}$$
$$V_{ij}^{I\prime} = (C_{A,ij}^{I} - C_{0,ij}^{I})G_{IQ}G_{ij}L_{ij}^{-1}$$
$$G_{ij} = (G_iG_j)^{1/2} \text{ and } L_{ij} = (L_iL_j)^{1/2}$$

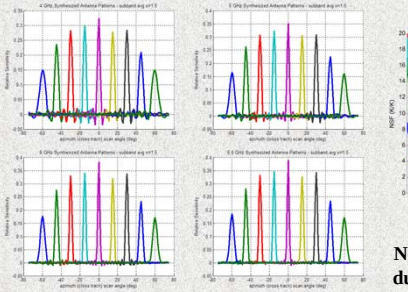
Anechoic Chamber Measurements Self- and Cross-Correlation

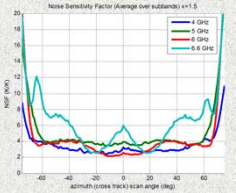


V_0 defines swathwidth

V_n defines spatial resolution

Synthesized Antenna Patterns and Image Noise Floor





NEΔT
Noise Multiplication Factor due to image reconstruction

Examples of Synthesized Antenna Patterns at 4,5,6,6.6 GHz, several cross-track locations